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CKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Nutritive Value of Mule Deer Forages On Ponderosa Pine Summer Range in Arizona

P. J. Urness,[1] D. J. Neff,[2] and R. K. Watkins[3]

Chemical analyses and apparent in vitro dry matter digestibilities were obtained for mule deer (*Odocoileus hemionus*) forages appearing in monthly diets. Relative values among individual forage species were calculated based upon nutrient contents and percentage composition in the diet. These data provide land managers with the means to more precisely assess some impacts of vegetation management practices upon mule deer habitat, and to aid in designing habitat improvements.

Keywords: Mule deer, nutritive values, forages, summer range, *Odocoileus hemionus.*

Forage quality on western deer summer ranges has seldom been accorded much concern because of the prevailing view that extent and quality of winter range limits herd size. However, recent studies have underscored the importance of high-quality summer range to assure good body condition and better winter survival (Nordan et al. 1968, Trout and Thiessen 1973, Snider and Asplund 1974). Nutritional levels in summer diets also appear to influence reproductive success (Swank 1958, Julander et al. 1961, Hungerford 1965).

[1]*Wildlife Biologist at the Station's Forest Hydrology Laboratory, at Tempe, in cooperation with Arizona State University, when research was conducted; now with Range Science Department, Utah State University, Logan. Station's central headquarters is maintained at Fort Collins, in cooperation with Colorado State University.*

[2]*Research Biologist, Arizona Game and Fish Department, Flagstaff.*

[3]*Wildlife Technician, at the Station's Forest Hydrology Laboratory, at Tempe.*

This study related values of individual forage species to dietary nutrients through diet composition data obtained by Neff (1974). An earlier report (Urness et al. 1975) summarized mean nutrient levels in monthly diets; this Note emphasizes the relative values among forages (table 1).

Ponderosa pine is an extensive forest type in Arizona; it occupies about 7 percent of the land area in a belt between 1,600 and 2,500 m (Nichol 1937). The ponderosa pine forest serves as spring-through-fall range for mule deer and elk (*Cervus canadensis*) and summer range for livestock (Reynolds 1972).

Precipitation ranges from 500 to 600 mm annually in a two-season pattern about equally divided between July-August monsoons and December-March snowstorms (Jameson 1969). Temperature extremes lie between -34°C and 38°C, with mean growing season temperatures ranging from 10°C and 16°C.

Understory vegetation is somewhat variable, depending upon tree density and site. Arizona fescue (*Festuca arizonica*) and mountain muhly (*Muhlenbergia montana*) are the usual dominants, but blue grama (*Bouteloua gracilis*), bottlebrush squirreltail

(*Sitanion hystrix*), and dropseed (*Sporobolus* spp.) are also common. Exotic grasses, frequently seeded along roadsides and on logged areas, include orchardgrass (*Dactylis glomerata*) and several wheatgrasses (*Agropyron* spp.). Native forbs are abundant; important genera include *Aster, Astragalus, Eriogonum, Geranium, Lotus, Lupinus, Senecio,* and many others. Common adventives include *Melilotus, Taraxacum, Tragopogon,* and *Trifolium.*

Common shrubs are Fendler ceanothus (*Ceanothus fendleri*), New Mexico locust (*Robinia neomexicana*), serviceberry (*Amelanchier utahensis*), and mountainmahogany (*Cercocarpus breviflorus*). Besides pine, Gambel oak (*Quercus gambelii*) is abundant in the overstory, and quaking aspen (*Populus tremuloides*) occurs as scattered patches on the more mesic sites at higher elevations.

Study Area and Methods

This study was conducted on the Beaver Creek watersheds near Stoneman Lake, 50 km south of Flagstaff on the southwestern slope of the Mogollon

Table 1.--Chemical analysis, in vitro dry matter digestibility, and relative importance (weighted value, proportional contribution to diet) of mule deer forages, Beaver Creek watershed, Arizona, May through September 1972-73

Month and plant species	Plant part	Diet composition	Protein		Acid-detergent fiber		Calcium		Phosphorus		Digestible dry matter	
			Nutrient content	Relative importance	Nutrient content	Relative importance	Nutrient content	Relative importance	Nutrient content	Relative importance	Nutrient content	Relative importance
		Pct	*Pct*		*Pct*		*Pct*		*Pct*		*Pct*	
MAY--												
Browse:												
Quercus gambelii	Leaves	11.8	24	11.6	22	10.2	0.25	6.5	0.57	14.5	58	10.4
Pinus ponderosa	Leaves;buds	6.4	7	1.8	36	9.1	.19	2.7	.13	1.7	39	3.8
Ceanothus fendleri	Leaves	2.8	22	2.6	25	2.8	.75	4.7	.44	2.6	59	2.5
Salix sp.	Leaves	.4	29	.5	28	.4	.63	.7	.83	.6	55	.3
Forbs:												
Trifolium sp.	Whole plant	15.4	33	21.0	25	15.1	.63	21.8	.57	19.2	76	18.0
Astragalus recurvus	Whole plant	13.1	23	12.8	27	13.9	.50	14.9	.37	10.6	72	14.3
Geranium sp.	Whole plant	7.0	14	4.0	27	7.4	1.00	15.8	.42	6.3	67	7.2
Lathyrus sp.	Whole plant	4.1	25	4.3	28	4.6	.88	8.1	.37	3.2	67	4.2
Vicia pulchella	Whole plant	2.2	28	2.6	28	2.5	.69	3.4	.60	2.8	70	2.4
Taraxacum officinale	Whole plant	.9	17	.6	30	1.1	.86	1.8	.50	1.1	59	.8
Geum sp.	Whole plant	.9	22	.8	14	.5	.50	1.1	.64	1.3	74	1.0
Aster commutatus	Whole plant	.2	18	.1	25	.2	1.00	.5	.57	.2	74	.2
Grasses:												
Dactylis glomerata	Leaves	26.7	31	34.9	23	24.8	.25	15.1	.57	32.8	76	31.1
Poa sp.	Leaves;flowers	3.8	12	1.9	40	6.1	.25	2.3	.30	2.4	52	3.0
Sitanion hystrix	Leaves;flowers	.9	12	.5	38	1.4	.31	.7	.32	.6	49	.7
TOTAL		96.6		100.0		100.0		100.0		100.0		100.0
JUNE--												
Browse:												
Quercus gambelii	Leaves	43.3	16	43.7	29	45.4	.44	28.9	.24	46.4	51	43.7
Cercocarpus breviflorus	Leaves	3.3	11	2.4	38	4.6	.94	4.7	.11	1.8	40	2.6
Ceanothus fendleri	Leaves	1.4	14	1.3	37	1.9	.78	1.7	.17	.9	46	1.3
Robinia neomexicana	Leaves	.8	25	1.3	25	.7	.63	.8	.32	1.3	39	.6
Pinus ponderosa	Leaves;buds	.6	8	.3	41	.9	.13	.2	.15	.4	41	.5
Amelanchier utahensis	Leaves	.5	13	.5	20	.4	1.44	1.1	.25	.4	54	.5
Forbs:												
Astragalus recurvus	Whole plant	13.2	17	14.9	30	14.4	.75	15.0	.19	11.2	67	17.7
Trifolium sp.	Whole plant	8.5	22	11.9	31	9.6	1.25	16.1	.28	10.7	63	10.7
Eriogonum racemosum	Whole plant	3.6	16	3.7	26	3.5	.63	3.5	.25	4.0	44	3.2
Lathyens sp.	Whole plant	3.6	24	5.6	28	3.7	1.44	7.9	.27	4.5	60	4.3
Taraxacum officinale	Whole plant	3.3	13	2.7	31	3.7	1.19	5.9	.36	5.4	60	3.9
Lotus wrightii	Whole plant	3.3	19	4.0	31	3.8	1.13	5.6	.21	3.1	39	2.6
Lactuca sp.	Whole plant	1.7	20	2.2	23	1.4	1.13	2.9	.37	2.7	70	2.4
Geranium sp.	Whole plant	.8	12	.6	30	.9	1.44	1.8	.37	1.3	58	.9
Melilotus officinalis	Whole plant	.6	22	.8	31	.7	1.13	1.1	.19	.5	65	.8
Tragopogon sp.	Whole plant	.6	15	.6	28	.6	.88	.8	.28	.9	67	.8
Vicia pulchella	Whole plant	.3	23	.5	37	.4	1.06	.5	.25	.5	62	.4
Oenothera sp.	Whole plant	.3	21	.4	17	.2	1.31	.6	.29	.5	72	.4
Grass:												
Dactylis glomerata	Leaves;flowers	2.6	15	2.5	34	3.2	.29	1.2	.31	3.6	54	2.8
TOTAL		92.3		100.0		100.0		100.0		100.0		100.0

Table 1.--Chemical analysis, in vitro dry matter digestibility, and relative importance (weighted value, porportional contribution to diet) of mule deer forages, Beaver Creek watershed, Arizona, May through September 1972-73--Continued

Month and plant species	Plant part	Diet composition	Protein: Nutrient content	Protein: Relative importance	Acid-detergent fiber: Nutrient content	Acid-detergent fiber: Relative importance	Calcium: Nutrient content	Calcium: Relative importance	Phosphorus: Nutrient content	Phosphorus: Relative importance	Digestible dry matter: Nutrient content	Digestible dry matter: Relative importance
		Pct	*Pct*		*Pct*		*Pct*		*Pct*		*Pct*	
JULY--												
Browse:												
Quercus gambelii	Leaves	40.3	12	32.0	31	42.1	.56	22.8	.14	31.1	46	34.3
Forbs:												
Melilotus officinalis	Whole plant	41.3	20	55.1	28	38.8	1.44	60.0	.22	50.6	66	50.8
Polygonum aviculare	Whole plant	4.5	11	3.3	42	6.4	1.00	4.5	.20	5.0	44	3.6
Dalea albiflora	Whole plant	3.1	19	3.8	31	3.2	1.06	3.5	.15	2.8	54	3.1
Geranium sp.	Whole plant	2.9	11	2.0	32	3.1	1.38	4.0	.29	4.4	55	3.0
Monardella odoratissima	Whole plant	1.6	7	.7	45	2.4	1.38	2.2	.20	1.7	51	1.5
Lactuca sp.	Whole plant	1.4	13	1.2	29	1.4	1.19	1.7	.25	2.2	69	1.8
Erigeron sp.	Whole plant	.3	12	.3	35	.4	1.06	.3	.21	.6	59	.3
Lotus wrightii	Whole plant	.2	16	.2	40	.3	1.44	.3	.16	Trace	38	.1
Desmanthus cooleyi	Whole plant	.2	15	.2	30	.2	1.13	.2	.14	Trace	38	.1
Grass:												
Sitanion hystrix	Whole plant	1.2	15	1.2	41	1.7	.50	.6	.24	1.7	59	1.3
TOTAL		97.0		100.0		100.0		100.0		100.0		100.0
AUGUST--												
Browse:												
Quercus gambelii	Leaves	50.5	12	50.2	31	52.3	0.75	49.7	0.18	50.6	41	49.5
Ceanothus fendleri	Leaves	6.9	19	10.3	27	6.3	.88	8.0	.18	6.0	51	8.4
Amelanchier utahensis	Leaves	1.4	11	1.2	26	1.2	1.75	3.3	.35	2.8	50	1.7
Cercocarpus breviflorus	Leaves	1.2	12	1.1	41	1.7	.75	1.2	.12	.6	46	1.3
Pinus ponderosa	Leaves	.2	6	.1	39	.3	.25	.1	.13	Trace	43	.2
Forbs:												
Lotus wrightii	Whole plant	9.4	14	10.8	34	10.7	1.13	13.9	.14	7.2	43	9.7
Eriogonum racemosum	Whole plant	5.7	13	5.7	35	6.8	.56	4.2	.22	7.2	34	4.7
Astragalus recurvus	Whole plant	3.1	20	5.0	29	3.1	.81	3.3	.19	3.3	72	5.3
Geranium sp.	Whole plant	2.0	9	1.3	31	2.1	.94	2.5	.29	3.3	55	2.6
Taraxacum officinale	Whole plant	1.8	11	1.6	40	2.4	1.13	2.6	.36	3.9	42	1.8
Lathyrus sp.	Whole plant	1.4	23	2.5	31	1.5	1.19	2.2	.22	1.7	65	2.2
Erigeron sp.	Whole plant	1.0	10	.8	30	1.0	.88	1.2	.26	1.7	64	1.5
Senecio neomexicanus	Whole plant	.8	11	.7	30	.8	.94	1.0	.25	1.1	57	1.1
Polygonum aviculare	Whole plant	.8	9	.6	34	.9	.63	.7	.18	.6	54	1.0
Lupinus sp.	Whole plant	.8	23	1.5	32	.9	.75	.8	.18	.6	66	1.2
Vicia pulchella	Whole plant	.8	20	1.3	43	1.1	.75	.8	.22	1.1	56	1.0
Desmanthus cooleyi	Whole plant	.7	17	1.0	34	.8	1.38	1.3	.14	.6	46	.8
Dalea albiflora	Whole plant	.5	15	.6	38	.6	.94	.7	.18	.6	53	.6
Gilia multiflora	Whole plant	.5	10	.4	33	.5	.69	.5	.24	.6	58	.7
Euphorbia fendleri	Whole plant	.2	12	.2	29	.2	1.06	.3	.43	.6	59	.3
Grass:												
Dactylis glomerata	Leaves	3.5	11	3.0	40	4.7	.38	1.7	.27	5.6	51	4.3
TOTAL		93.2		100.0		100.0		100.0		100.0		100.0
SEPTEMBER--												
Browse:												
Quercus gambelii	Leaves	48.6	12	58.8	31	50.0	.88	43.9	.20	43.5	46	49.0
Forbs:												
Eriogonum racemosum	Whole plant	12.8	10	13.6	33	14.1	1.13	14.9	.39	22.4	40	11.1
Gilia multiflora	Whole plant	9.6	8	7.4	33	10.4	1.44	14.1	.22	9.4	55	11.5
Erigeron sp.	Whole plant	8.5	7	6.5	33	9.4	1.19	10.3	.22	8.5	58	10.6
Taraxacum officinale	Whole plant	4.0	12	4.7	32	4.2	1.38	5.6	.42	7.6	54	4.7
Aster commutatus	Whole plant	3.0	9	2.7	33	3.2	1.75	5.4	.13	1.8	68	4.4
Senecio neomexicanus	Whole plant	2.1	8	1.7	35	2.5	.81	1.7	.20	1.8	57	2.6
Euphorbia fendleri	Whole plant	2.0	8	1.7	33	2.2	.50	1.0	.16	1.3	56	2.4
Geranium sp.	Whole plant	.8	6	.5	38	1.0	.63	.5	.20	.9	56	1.0
Potentilla sp.	Whole plant	.6	7	.4	35	.7	.88	.5	.20	.4	57	.7
Lotus wrightii	Whole plant	.5	11	.5	39	.6	1.56	.8	.44	.9	42	.5
Desmanthus cooleyi	Whole plant	.4	14	.6	28	.4	.69	.3	.28	.4	50	.4
Amaranthus sp.	Whole plant	.4	9	.3	51	.7	1.00	.4	.28	.4	44	.4
Aster sp.	Whole plant	.4	8	.3	36	.5	.69	.3	.25	.4	60	.5
Grass:												
Bouteloua gracilis	Leaves	.2	9	.2	41	.3	.38	.1	.18	Trace	49	.2
TOTAL		93.9		100.0		100.0		100.0		100.0		100.0

Plateau. Dietary composition was determined on ponderosa pine summer range during numerous trials using tame deer (Neff 1974). Data were taken on species consumed, number of bites per species, and average weight per bite estimated from weighed simulated bites. Monthly dietary composition (May-September) was estimated from percentages of total consumption contributed by individual forage species from all trials during the month. The estimate for the July diet, based on only 650 total bites, was weakest; the other months ranged from about 3,000 to 12,000 bites.

Plant parts eaten by trained deer were hand clipped at Beaver Creek in 1972 and 1973. The objective was to sample all forages appearing in monthly diets, but actual percentages tested ranged from 92 to 97. Composited samples of individual forages from 25 or more plants were ovendried at 65°C (Schmid et al. 1970) to constant weight, ground in a Wiley mill[4] through a 16-mesh per cm screen, and stored in sealed jars. Standard chemical analyses for crude protein, acid-detergent fiber, calcium, and phosphorus were completed by a commercial laboratory (table 1).

In vitro digestibility percentages (Tilley and Terry 1963) were obtained by using rumen inocula from deer killed on pine watersheds at Beaver Creek within a week of plant collection. Rumen contents were placed in insulated bottles and taken to the Forest Hydrology Laboratory at Tempe within a maximum lapsed time of 3 hours. Fluids were separated from rumen solids by straining through four layers of cheesecloth into preheated (39°C) buffer solution at the ratio of one part fluid to four parts buffer solution.

Half-gram forage samples and 50 ml of buffered inocula were placed in 100-ml digestion tubes fitted with gas valves. Fermentations proceeded in a constant-temperature water bath (39°C) for 48 hours, followed by an acid:pepsin phase for a like period. The tubes were swirled every 4 hours for the first 12 hours, then on a 12-hour schedule until the end of the trial. Filtration and drying of insoluble residues on tared filter paper completed the process. Digestion percentages were calculated by subtracting residual dry weight from original sample dry weight, corrected for inocula dry weight.

Relative values of individual forages were estimated by multiplying their monthly nutrient content percentages by monthly dietary composition percentage. The weighted values were totaled and a percentage value for each forage calculated as its proportional contribution to the total.

[4] *The use of trade and company names is for the benefit of the reader; such use does not constitute an official endorsement or approval of any service or product by the U.S. Department of Agriculture to the exclusion of others that may be suitable.*

Results

Since deer characteristically feed on a wide array of forage species, analyses of nutritional value are complex. Specific relationships established at one location cannot be assumed to offer precise estimates elsewhere. The ponderosa pine type in Arizona, however, is relatively homogeneous in vegetational composition and other habitat factors, and, the data presented here have considerable application across the type.

While mean percentages of dietary nutrients provide a useful measure of potential range deficiencies or adequacy of habitat to produce deer, the relative values of individual forage species are also important. More precise assessments of impacts on deer from resource management activities can be made from an understanding of (1) plant composition changes wrought by these activities, and (2) the contribution of affected plants to the deer forage resource. Alterations in cover values are also significant (Reynolds 1966). Table 1 presents chemical analyses and in vitro dry-matter digestibilities for May-through-September diets of mule deer.

May.—The species listed in table 1 comprised almost 97 percent of the May diet. Only a few species contributed the bulk of dietary nutrients, but overall quality was excellent with few exceptions. Most species were high in protein, phosphorus, and digestibility; moderate in calcium; and low in acid-detergent fiber.

The most important species was a seeded exotic, orchardgrass (*Dactylis glomerata*), which was of considerable value and attractiveness to deer in early spring (Hungerford 1965). Clover (*Trifolium* sp.) and locoweed (*Astragalus recurvus*) were the primary forbs, but neither was highly available. Gambel oak (*Quercus gambelii*) was the major browse, taken at this period as immature leaves.

June.—Nutrient content changed abruptly from May levels with advancing maturity of many forages, and species shifts to browse from grass (table 1). Although protein remained generally high, there was a sharp decline in browse species and orchardgrass. Fiber content increased with corresponding decreases in digestibility, but the latter remained high for most forbs and some browse species. Calcium content increased markedly in most forages, and phosphorus declined, resulting in wider P:Ca ratios.

Gambel oak leaves were important in June diets (92 percent was analyzed) despite the abundance of forbs during this period. For this reason Gambel oak, particularly in a form available as browse to deer, should be prominent in any habitat development plan. Mast crops from this tree are also important (Reynolds et al. 1970).

The same two forbs, clover and locoweed, remained prominent in June. Several new species were added, but overall forb percentages changed little.

July.—A strong shift to forbs appeared in July, mostly to new species that develop following midsummer rains. Foremost among them was sweetclover (*Melilotus officinalis*), a seeded adventive.

Gambel oak was the only important browse, and although it had declined greatly in protein content, its moderate calcium level tended to offset the high levels in forbs to keep overall P:Ca levels within acceptable limits.

August.—Again Gambel oak predominated, but maturity had reduced its quality to average levels. Less abundant browse such as Fendler ceanothus and serviceberry were superior to Gambel oak in most respects.

Use of forbs declined in August and their quality was inconsistent. That is, species with good protein levels may have been low in digestibility and phosphorus or the reverse. Overall quality was still quite satisfactory.

September.—The value of Gambel oak in terms of quantity consumed and quality was accentuated during late summer. It retained a good protein level while that of most other species had declined abruptly. Gambel oak also contained less calcium, which balanced the much higher levels in forbs to maintain an acceptable overall P:Ca ratio. Conversely, most forbs were more digestible than oak leaves, and contained more phosphorus.

Summary.—Although forage quality generally declines from early summer to fall, dietary nutrient levels for mule deer on ponderosa pine summer ranges are adequate or better for deer growth and reasonable production (table 2). The lower values occur toward the end of summer when physiological demands for high-quality diets are much reduced for adult deer and to some extent for fawns.

Complete diets were not analyzed. Omissions tend to include species of restricted availability but frequently of high nutritive value. Consequently, dietary nutrient estimates are somewhat conservative. Other factors associated with laboratory analyses likewise can contribute to results that underestimate actual values for some nutrient factors.

Table 2.--Estimated nutrient levels in summer diets of mule deer derived by weighting values of individual forages

Month	Digestible dry matter	Protein	Acid-detergent fiber	Calcium	Phosphorus	P:Ca ratio	Proportion of diet analyzed
	- - - -	Percent	- - - -	- - - -			Percent
May	68	25	26	0.46	0.48	1:1.0	97
June	54	17	29	.72	.24	1:3.0	92
July	56	16	31	1.02	.19	1:5.4	97
Aug.	46	14	32	.82	.19	1:4.3	93
Sept.	49	10	32	1.04	.24	1:4.3	94
Mean	55	16	30	.81	.27	1:3.0	--

Forages contribute nutrients to deer diets roughly in proportion to their percentage composition, especially those making up sizable percentages in the diet. Since only a few species usually dominate monthly diets, opportunities abound to positively affect deer habitat through alterations in the food supply. For example, some pine stands have but small amounts of oak browse within reach of deer. Management practices are available to stimulate oak sprouts and to periodically reduce their height. Seeding disturbed sites such as logged areas and wildfire burns to orchardgrass, sweetclover, and other nutritious and palatable species is also recommended.

Finally, maintenance of maximum diversity is desirable. Few forage species alone supply a good balance of nutrients, and phenological changes often mean that a particular species is a high-value forage for a relatively short time.

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